DISTRIBUTION OF IRON IN RURAL GROUNDWATER OF BENUE STATE, NIGERIA

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ABSTRACT

This study examines iron level in groundwater from boreholes and their spatial distribution across rural communities of Benue State. Water samples were collected from 26 boreholes and analyesd for iron concentrations as it affect the quality of drinking water as prescribed by WHO standards. The analyses were done according to standard method of water examination. The results of analyses show 35% of the boreholes have high iron concentrations above WHO guide limit for drinking water. The concentration level was also found to vary spatially across the study area. The iron concentrations in the boreholes ranged between 0.03-2.38mg/l with a mean and coefficient of variation of 0.82mg/l, CV81.71% respectively. The presence of iron in rural groundwater in study area may be traced to the local environment of the boreholes.These include the geology, dissolution of iron minerals from rock and soil, precipitation/run off and infiltration activities, use of galvanized materials in handpump construction and agricultural landuse activities. Although iron concentrations at objectionable level were noted in some of the boreholes villagers were found using them for drinking in the absence of any other alternative.Some form of treatment like filtering and or Reverse Osmosis if can be afforded may be required to reduce the risk to health over time. The study has demonstrated the need for groundwater quality monitoring and management in the rural areas to ensure the safety of water being provided.

INTRODUCTION

The United Nations considers universal access to clean safe water a basic human right, and an essential step towards improving living standards worldwide. Water-poor communities are typically economically poor as well and their residents are trapped in an ongoing cycle of poverty. Over one billion people lack access to safe clean water worldwide. Polluted water is not just dirty, it is deadly(NSA,2009).Water related diseases are a human tragedy, killing millions of people each year, preventing millions of people from leading a healthy lives and undermining development efforts(NASH,1993).About 2.3 billion in the world suffer from diseases that are linked to water(Kristof,1977;United Nations,1997.

In Benue State, the task of meeting rural water needs is quite enormous. About 75% of the population is residing in rural areas and are faced with acute water shortage especially in the dry season. Traditional sources such as streams, rivers and ponds available to rural areas are under intense stress from various deforestation activities like agricultural intensification, land clearance, bush burning coupled with climate change. Consequently some of these sources are exposed to direct solar radition leading to high evaporation making them to dry up. Beside, uncontrolled activities of cattle Fulani are also creating pollution problem of these sources thus further limiting the available usable sources for drinking. Women and children who are the major drawers of water suffer untold hardships searching for water for household use. In 1986, there was an outbreak of water related disease that claimed several in Oju/Obi LGAs of the state. Subsequently, in 1995 and 1995 Benue State Rural Water Supply and Sanitation Agency a UNICEF Assisted and WaterAid a British DFID funded water charity commenced activities of providing rural communities with borehole water sources. Although a welcome development, water from some of these boreholes is of doubtful quality due to the presence of colour, odour and taste which are indications of pollution. Two major challenges are facing these organizations. On one hand, is to make water available, and on the other of hand is the safety of water being provided for drinking. According to WHO (2006) consumers to large extent have no means of judging the safety of water themselves, but their attitude toward drinking water supplies will be affected to a considerable extent by the aspects of water quality they are able to perceive with their senses. It is natural for consumers to regard with suspicion water that appear dirty or has unpleasant taste or smell, even though these characteristics may not in themselves be of direct health consequence. Holmberg(1983) concluded that providing water which is not safe amounts to a 'hydrocide' another poison.People in the absence of any other alternative are compelled to drink this water thus endangering their lives.

To address the issue of rural water supply problems especially in the developing countries, organizations rely on groundwater exploitation as the only realistic option(MacDonald, et al,2005).Groundwater is available anywhere. It not susceptible to pollution and drought like surface water sources. It is cheaper to develop and maintain unlike surface water that require treatment plant with necessary treatment processes (Carter Howsom,1994; Calow,et al,1997; Habila,2005). Despite these advantages, the quality of groundwater is affected by increasing demand and withdrawal, changes in landuse pattern, climate change,and pollution from geology and geochemistry of the environment(Mackey,1990; Edmunds and Smedley,1996).This concern has attracted studies in different parts of Nigeria(Akintola, Acho-Chi and Mark,1980; Faniran,1986; Abibio,1988; Ezeigbo,1988; Adekunle,Adetunji,Gbadebo and Banjoko,2007, Njoku, Ebeh and Samson,2009; Ocheri and Oklo,2009).Consistent in their findings is that groundwater is polluted from point and non-point sources of pollution.

High concentrations of iron in groundwater are widespread and sometimes underrated constraints on rural water supply.Iron can cause colour change in water which may lead to a consumer rejecting such water. This kind of water when used can cause staining of cloth, utensils and food and has bitter taste. Although this has no direct health significance, but problem may arise if communities decide not to use this water and return to old polluted sources (MacDonald et al, 2005).All natural water contains some dissolved iron in traces. Iron is present in all rocks, soil and sand. The most common form is ferrous iron.Water which contains iron on exposure to air become reddish brown due to the ferric hydroxide.Human beings suffer no harmful effect of water containing iron. However, long term consumption of drinking water with high concentration can lead to liver disease(Morris,1952;Lee and Stum1960;Hem,1970). In Ghana, 20 to 30% of boreholes drilled for water supplies contain excessive iron concentration.Water from these boreholes have been rejected by the rural population on account of coloration effect(Peligba et al,1991).Groundwater in the confined aquifer of sedimentary basin are particulary vulnerable to build-up of dissolved iron and manganese under anaerobic condition(Okagbu,1988; Akujieze, et al,2003; Amadi, et al,1989; BGS,2003).

The objective of this study is to assess the concentrations of iron in boreholes and their spatial variability across some rural communities of Benue State. This will serve as useful guide to organizations involved in rural water supply. The concern of this study is captured by MacDonald et at (2005) who observed that, due to many advantages of using groundwater, many rural water supply projects rely on developing groundwater, but do so blindly, with little regard to quality. Boreholes are sited at random, or by socio-economic criteria alone, the water supplies are assumed to be safe and sustainable with no water quality testing or understanding of the nature of the resource.

MATERIALS AND METHODS

This study was carried in some rural communities in 13 LGAs of Benue State(Table). The area lies between Lat.$6^{o}32^{1}$N and $8^{o}07$N and Long.$7^{o}52^{1}$E and $10^{o}00^{1}$E and has a population of 2,195,041(NPC,2006). The area is underlain by a geological formation which is predominantly sedimentary and is made up of sandstones, mudstones and limestone(Kogbe,et al,1978; Nwachukwu,1972; Offodile,2002) and classified into Awgu and Eze -Aku groups(MacDonald et al 2005). Basement complex are found places like Gboko, Ushongo, Guma, Vandeikya and Oju LGAs.The topography of the study area is averaging low with exception of Oju and Gboko LGAs having hills of appreciable heights. Major rivers that drain the area include River Benue and its tributary ,the River Katsina-Ala. Other rivers include Aya, Guma , Konshisha, Logo, Mu, Okpokwu, Obi etc.The soil is predominantly of tropical ferrugised type with hydromorphic soil along river floodplain. Skeletal lateric soil are found within the hilly areas. The study area has a tropical sub-humid climate with two distinct seasons, wet and dry season.Annual rainfall total ranges from 1,200mm to 2000mm. Temperatures are generally high particularly in the months of march and April. The vegetation of the study is of savanna type dominated and interspersed with trees.

Data for this study were obtained from water samples collected from 26 rural community boreholes in Benue State.Through random sampling two boreholes each from two communities in the 13LGAS were selected for study. This is decision was informed by the prevalence of non functional boreholes without water or broken down unrehabilited, availability and accessibility factors. For instance, in the whole of Ogbadibo LGA there boreholes. This is attributed to the far depth of groundwater table which cannot be accessed by handpumped borehole system.

Water samples were collected in the month of October when rainfall is highest in the study area and high pollution of water sources is expected.The analyses was done according to standard method of water examination(APHA-AWWA-WPCF,1995) and reported in line with the WHO(2006) prescribed limit for drinking water. The iron concentration in water were analysed using atomic aborption spectrophotomeric technique. UNICAM Solaar 32 model was used.The method is based on the absorption of radiation by free atoms in vapour state.The atoms of element whose lamp or flamp is being absorbed at precisely the same wave length as that emitted by its light source.The amount of energy at the characteristic wave length absorbed by the flame is proportional to the concentration of the element in the sample over a limited concentration range.The results of AAS analyses is shown in Table 1.

Results and Discussion

Table 1: Iron concentration in rural groundwater of Benue State

Community	Code	Iron(mg/l)	Community	Code	Iron(mg/l)
Ikpayongo	BH1	0.85	Ake	BH14	0.24
Tsenor	BH2	0.50	Uchi-Mbakor	BH15	1.11
Awajir	BH3	1.11	Annune	BH16	2.16
Kyoor	BH4	2.38	Ambighir	BH17	0.09
Ega	BH5	0.54	Tse Kucha	BH18	0.03
Uje	BH6	2.20	Garagbohol	BH19	1.07
Obarike-Ito	BH7	0.08	Buruku	BH20	0.35
Ugbodom	BH8	0.55	Sati-Asema	BH21	0.43
Ogi	BH9	0.10	Amaafu	BH22	0.32
Ulayi	BH10	0.71	Mbaagba	BH23	1.11
Asaage Ashe	BH11	0.21	Ushongo	BH24	1.52
Udei	BH12	0.59	Ihugh	BH25	0.10
Fiidi	BH13	0.48	Mbajor	BH26	1.38

Table2: Descriptive characteristics of iron in rural groundwater of Benue State

Min.	Max.	Mean	STD	CV%
0.03mg/l	2.38mg/l	0.82	0.69	81.71

STD-Standard Deviation CV% Coefficent of Variation

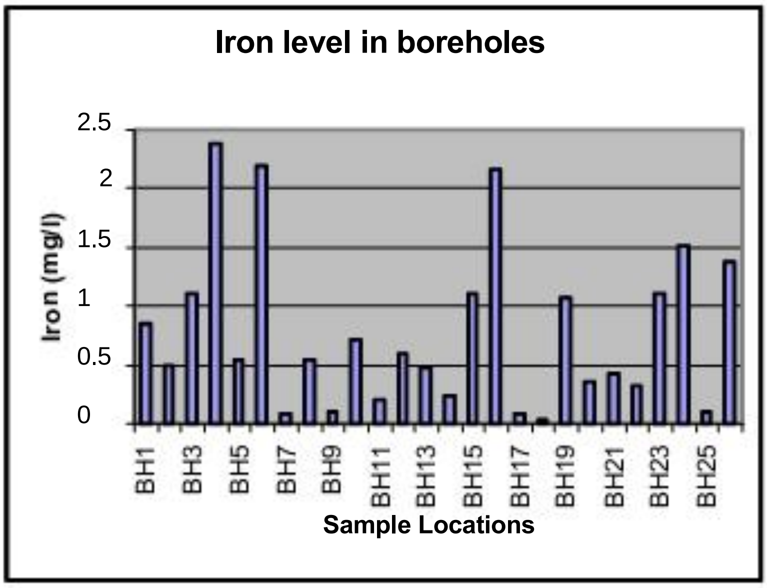

Fig.1 Iron distribution in rural groundwater of Benue State

The results of analyses of iron concentrations as shown in Table 1 reveal that out of 26 boreholes studied 8 have high iron levels above the WHO prescribed limit of 0.1-1.0 mg/L for drinking water. This translate into 35 % of the boreholes having iron concentrations above WHO guide limit.The boreholes are H4(Kyoor-Konshisha LGA) 2 .38 mg /L ,BH 6 (uje -Oju LGA) 2 .20 mg /L ,BH 16 (Annune -Tarka LGA) 2.16mg/L,BH24(Ushongo-Ushongo LGA) 1.52mg/L,BH 26(Mbajor-Vandeikya LGA) 1.38 mg/L,BH3(Awajir-Konshisha LGA) 1.11mg/L,BH 15(Uchi-Mbakor-Tarka LGA) 1.11mg/L,BH 23(Mbaagba-Ushongo LGA) 1.11mg/L,BH 19(Garagbohol- Buruku LGA) 1.07 mg/L. From the analyses, all the boreholes sampled for the study in Konshisha,Ushongo and Tarka LGAs have iron levels above the WHO allowable limit for drinking water. The concentration level of iron was also noted to vary among the boreholes. From Table 2 iron level in the study area ranged between 0.03 2.38mg/l, with a mean and coefficient of variation of 0.82mg/l CV % 81.71. The variation in the concentration level of iron in the boreholes may be attributed to the local environment of the sources. These include geology of the environment, precipitation and run off /infiltration, dissolution of iron mineral from rocks and soils, use of galvanized hand pump fittings and landuse activities.Water from BH 4, BH 3, could not used for drinking due to the presence of highly objectionable colour. However,other boreholes with objectionable colour problem are being used for drinking in the absence of any other alternative. Prolonged ingestion of this kind of water may wreck health implications over time. The distribution of iron in rural groundwater of Benue State is shown in Fig.1.

CONCLUSION

The study has revealed the presence of iron in all the boreholes in their varied concentrations in the study area. Iron concentrations at objectionable level were noted in some of the boreholes leading to disuse of water for drinking. Whereas, some of the boreholes with such iron level are used for drinking which exposes the consumer of such water to health risks over time. One form of treatment or other may be required to reduce such risks.Iron contaminated water may exposed about an hour and therefore filtered. Reverse Osmosis although effective in iron treatment may be expensive for rural population.Rural water supply agencies should make provision of good quality a top priority and not just making water available. This study has demonstrated the need for groundwater quality management for rural use.

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